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Energy a Critical Enabler of Economic Productivity

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Abstract

This article is about energy on the world economy and its impact on environment. The resources that supply energy are essential to human survival. The intense exploitation of these resources has enabled the development of highly technological societies in the world's wealthier countries. But with the benefits of energy comes a dilemma. How can society keep providing humankind with energy-derived advantages without damaging the environment, affecting societal stability, or threatening the well-being of future generations? The resolution of this dilemma involves finding sustainable energy sources. Many experts view our energy-use pathways as unsustainable for the long-term future if present growth trends continue. A better future might depend strongly on how individuals and institutions choose among diverse and potentially contradictory technical, sociological, geopolitical, and environmental options, and how each of us set priorities for changing our present courses. This article presents an overview of the development of energy technology, energy resources, and energy technologies available today, and how it threatens our survivability for the future. But the issues surrounding the future role of energy extend far beyond technology, since energy use is integral to many activities, including our quality of life, our commerce, our mobility, and the stability of our social institutions. Our energy use impacts the environment in ways that may be irreversible — especially as the human footprint on the planet expands due to population increases. Population growth and economic growth lead to increased demands on natural resources and greater individual energy consumption. Moreover, the uneven geographic distribution of primary resources creates significant geopolitical consequences. Taken together, these factors pose substantial challenges to achieving a sustainable future. The goals of this article are to clearly present the trade-offs between economy and environment inherent in defining sustainability, to study technology and technology-intensive policy options, and to provide a framework for assessing solution options. The approach is quantitative, though not encyclopedic. It's high time for all to examine available and future technologies in the context of their environmental strengths and weaknesses, their technical and economic viability, and their ability to keep pace with evolving public and regulatory expectations for the sustainable use of the planet's resources.

Keywords

Economics, Energy, Electricity, Environment, Climate change, Ecosystem, The Human Disruption Index, Anthropogenic, Renewable Energy.

1. Introduction: Energy in the World Economy and Its Impact on Environment.

Can we imagine ourselves without energy? The answer to this question is simply 'no'. Can the present society stop using vehicles and transport systems, stop factories producing goods, stop using electricity in households, close hospitals, etc.? No. The process is irreversible. When we think in terms of any human activity, any human activity needs energy. So, if you look at this article that you read now, it needs paper, a press to print, and then transported to make it available in your hand or on digital media to read. If you look at the comfort conditions when think in terms of air conditioning or cooling, those also need energy. Energy a critical enabler of economic productivity.

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An energy system offers a variety of choices for individuals, companies, and society. The history of human development has been characterized by increasing use of energy. It has been witnessed unprecedented growth in terms of human comfort and quality of life. But coupled with this, now facing severe problems both in terms of health, in terms of the local environment, and in terms of climate change. So, climate change has now reached the dimensions of a crisis, and we are looking at ways in which we can make our energy system sustainable. Most decisions in the real world are based on economics.

1. Environmental Economics
2. Resource Economics
3. Welfare Economics.

These are necessary for energy system analysis and environmental impact analysis. What are the types of energy systems and their impacts on the environment and society? Energy is one of the major inputs for the economic development of any country. Presently, it is becoming more important as demand is increasing day by day in the modern technological environment. In the past, it was not so important.

1. The first wave of inventions in the 17th century, which lasted for 60 years beginning in 1785, were water power, textiles, and Iron. This was the period of the agricultural revolution.
2. The second wave of inventions in the 18th Century was rail and steel, which lasted for 55 years between 1845 and 1900. It was the period; industrial revolutions took place.
3. The third wave of inventions in the 19th Century began in 1900 and ended at the end of the first half of the century. They are electricity, chemicals, and internal combustion engines. It was the time period; technical revolution took place. The fourth wave was powered by oil, electronics, aviation, and mass production.
4. In the 20th century, we are now in the midst of the 5th wave, dominated by semiconductors, fiber optics, genetics, software, and artificial intelligence, which started around 1980. Even this wave may end soon; are in a transitioning zone to enter the 6th wave.

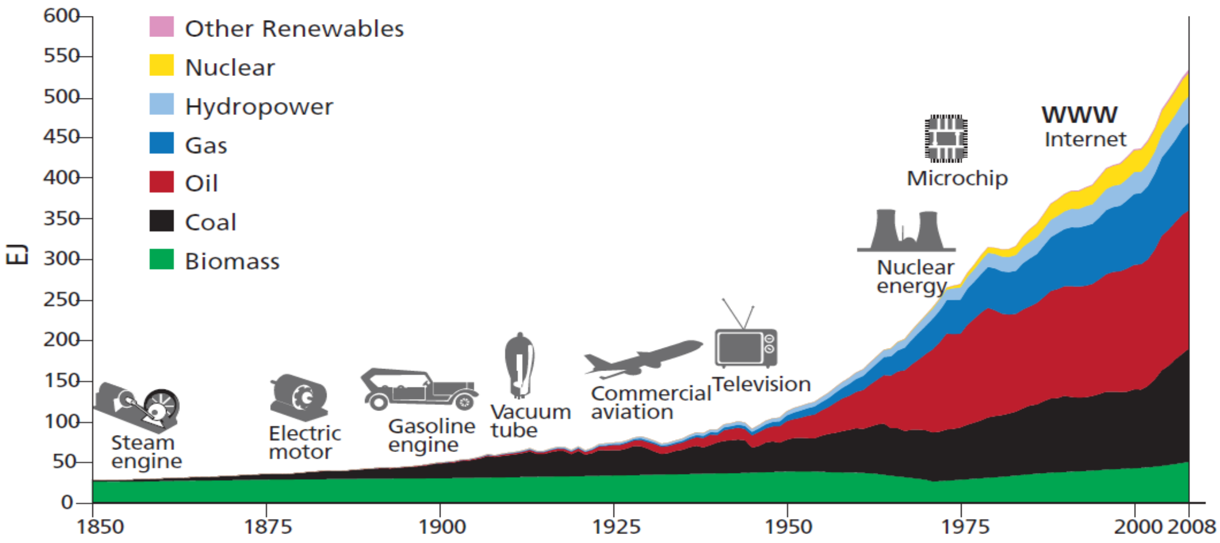


Figure 1. World Primary Energy Use **(GEA standard)**

Where the energy comes from?

So, when talk about energy resources, there are some questions that you may want to think about. You might have heard the term peak oil. So, what is this peak oil? Do we believe in peak oil, peak coal, and peak natural gas? When look at India or the world, see that, predominantly today, our energy use is based on fossil fuels. So, the question that to ask is, Are fossil fuels depletable? Will their consumption decline? How soon will they decline? How long will fossil fuels last? And so, these are some of the things that should be consider. When talk about resources, the energy resources can be stocks or flows. There is this interesting quote from the Saudi Arabian oil minister, Ahmed Zaki Yamani, who said that **"The Stone Age did not end for lack of stone, and the oil age will end long before the world runs out of oil."**

2 Energy Resources : Energy Flow Diagram

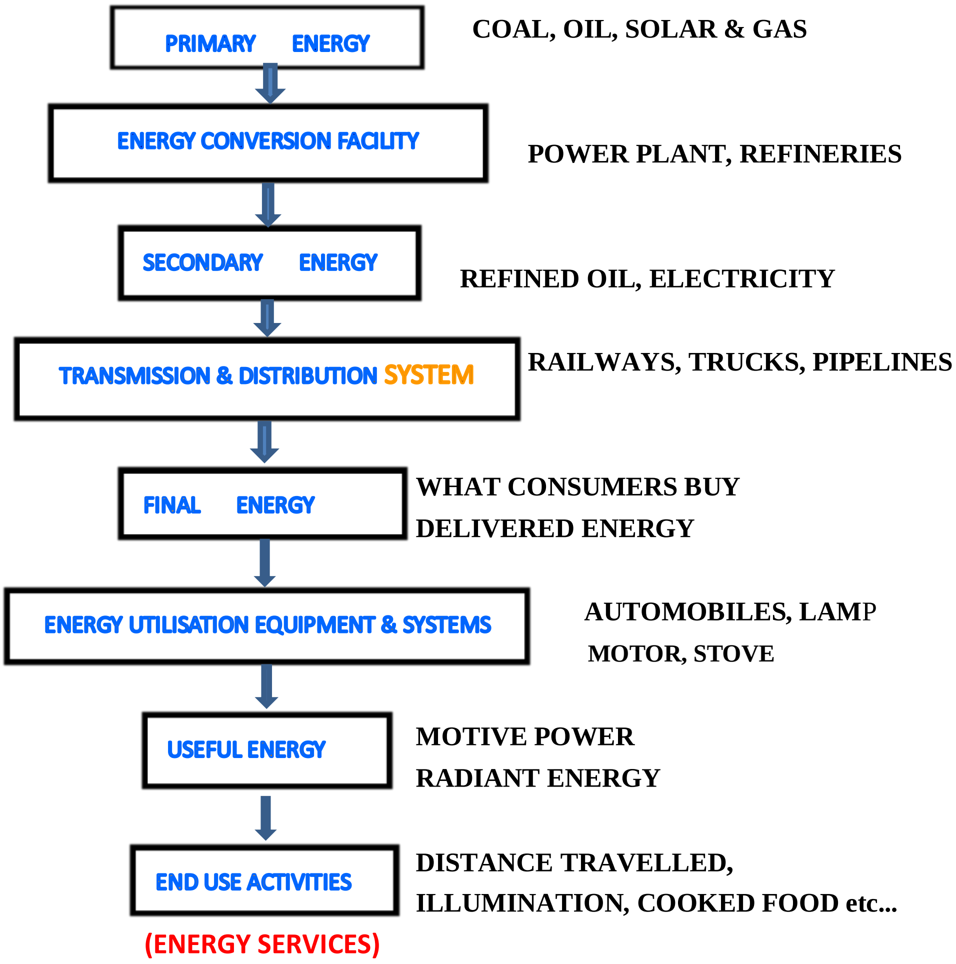


Figure2. Energy Flow Diagram.

So that energy comes through a whole sequence of steps. The energy that is available in nature, which is primary energy, is the energy source, like coal, oil, solar, natural gas, wind, etc. The energy that is available in nature is not something that can be directly used. In an energy conversion facility, you can take that energy and transform it. So, first take the coal, convert it, mine it, wash it, transfer it to a power plant, and then get the secondary energy. So, secondary energy is the electricity that we get from the power plant, which burns coal. That secondary energy itself goes through a whole network, a transmission and distribution system. And then it reaches your house or it reaches the campus—the final energy that one buy from the distribution company. Then it goes and is used in your air conditioners, in the fans, and in the lights to give you useful energy for your end-use activities. So, when you talk about each of these conversion steps, each conversion step needs a certain amount of energy for the conversion, so if you need 1 unit of useful energy, would probably need 2 or 3 units of primary energy. So, whenever one use one unit of useful energy, two or three units of primary energy are being spent from the earth's capital. So, at each of these steps, some amount of energy is used, and in using that energy, there is also some adverse impact and an environmental impact.

2.1 Energy Life Cycle

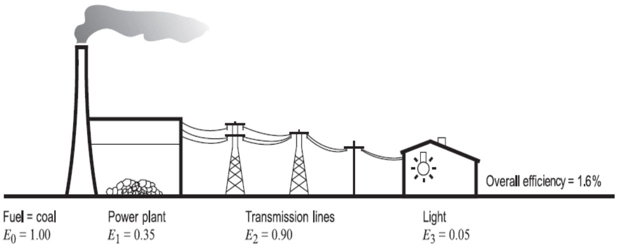


Figure 3. Energy Life Cycle.[1]

Overall efficiency for converting chemical Energy to light energy: $E_1 \times E_2 \times E_3 = 0.016 = 1.16$ %

When coal came into widespread use in the nineteenth century, it fuelled the Industrial Revolution, resulting in increases in economic growth and urbanization. The discovery of oil and natural gas in the twentieth century further encouraged economic growth and increased total energy consumption. These fuels also were available to provide large amounts of power that could be readily controlled to meet the variable demands of consumers and industrial users. Such exponential growth has raised other important questions: first, the broader life-cycle question of whether the cumulative global and local use of the primary source is depleting the resource base in a way that will create future shortages; and second, whether the extraction activities and waste products from expanding operations are seriously endangering the environment. These concerns are compounded as less wealthy nations aspire to use fossil energy to develop their economies for the benefit of their citizens. Today nations around the world are re-evaluating the implications of the fossil-fuel bonanza, thinking the expansion of nuclear power, and encouraging deployment of renewable sources of energy.

2.2 History of World Primary Energy Use

Energy is essential for human development, and energy systems are crucial entry points for addressing the global challenges of the 21st century, including sustainable economic and social development, poverty eradication, adequate food production and food security, health for all, climate protection, conservation of ecosystems, peace, and security. Yet more than a decade into the 21st century, current energy systems do not meet these challenges.

A major transformation is therefore required to address these challenges and avoid potentially catastrophic failures for human and planetary systems.

Despite this rapid increase in overall energy use, over three billion people still rely on solid fuels such as traditional biomass, waste, charcoal, and coal for household cooking and heating. The resulting air pollution leads to over two million premature deaths per year, mostly of women and children. Furthermore, approximately 20% of the global population has no access to electricity. Addressing these challenges is essential for averting a future with high economic and social costs and adverse environmental impacts on all scales.

2.3 ***Share*** of world total energy supply and consumption by source, 2021 are shown in figure 4 and figure 5.

1. World includes international aviation and international marine bunkers.
2. In these graphs, peat and oil shale are aggregated with coal.
3. Data for biofuels and waste final consumption have been estimated for a number of countries.
4. Includes heat, solar thermal and geothermal.

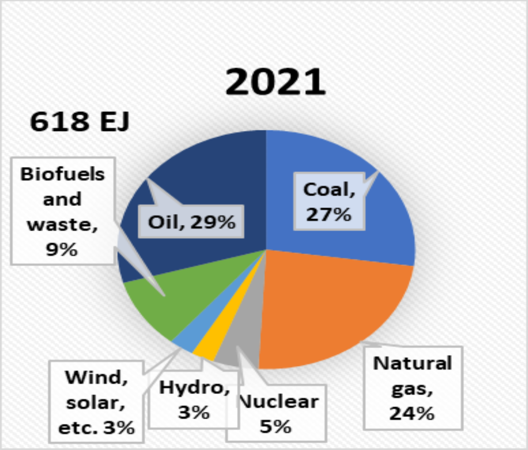


Figure 4. Share of World Total Energy Consumption[2]

An energy system transformation is required to meet these challenges and bring prosperity and wellbeing to the 9 billion people expected by 2050. The encouraging news is that a beginning of such a transformation can be seen today in the rapidly growing investments in renewable energy sources, high-efficiency technologies, new infrastructure, near zero energy buildings, electric mobility, 'smart' energy systems, advanced biomass stoves, and many other innovations. The policy challenge is to accelerate, amplify and help make the implementation of these changes possible, widespread and affordable. Initial experience suggests that many of these changes are affordable, although they may be capital intensive and require high upfront investments. Many of these innovations also lead to benefits in other areas such as equity and poverty, economic development, energy security, improved health, climate change mitigation, and ecosystem protection.

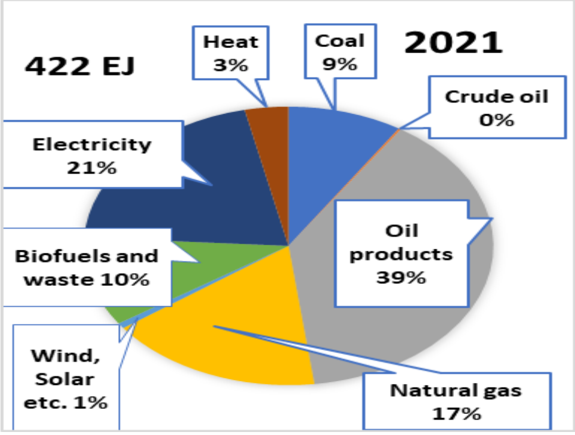


Figure 5. Share of World Total Energy Supply[2]

Issues:

1. Why is the environment important?
2. How do energy systems impact the environment?
3. Is there a trade -off between environment and economic development?

4. What are the major impacts and causes?
5. How a sustainable future can be ensured?

3. Energy System with Environment: When you look at an energy system operating, we are using some natural resources, some human resources, and, in the process, generating useful goods and services to serve the intended users. But in producing that, there are unintended impacts that can't avoid that exacerbate adverse environmental effects or may give rise to new problems, including industrial accidents, different emission products, or radiative effluents. It will have different kinds of impacts, either on humans or on the ecosystem.

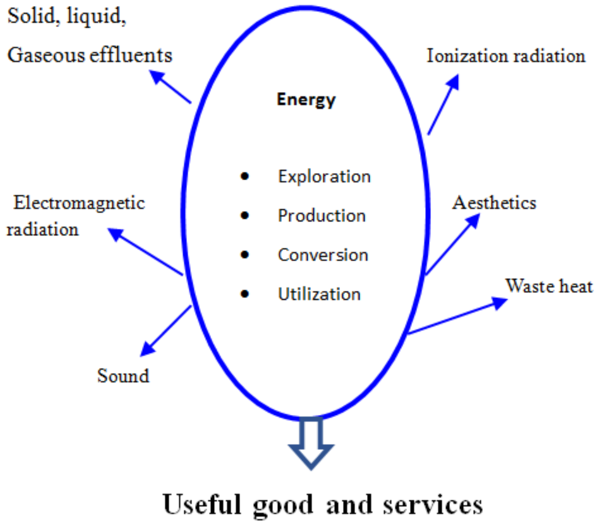


Figure 6. Interaction of Energy Systems with Environment **[1]**.

The energy that is being consumed, majorly by burning fossil fuels, the pollutants generated are NOx, So_x, CO, SPM, CO_2, CFC etc. In many of these situations, when we use a certain amount of energy, we also reject some heat, which is waste heat, and this causes, for instance, an urban heat island effect where some portions of the cities would have much hotter temperatures. And then there are ways in which we try to mitigate this. It has an adverse health impact from local to global disruption as human energy use increases. Professor John Holdren of Harvard University proposed an index called "The human disruption index," and this was to look at the disruption at a global scale of a particular pollutant. his is defined very simply as the ratio of the human generated flow of a given pollutant to the natural, or baseline, flow. So, the idea is that, in cases where the human generated flow of a pollutant is orders of magnitude less than the natural or baseline flow, nature has the ability to manage it and nature will not show up as a problem, but the moment it becomes of the same order of magnitude as the natural or baseline flow, then there are problems because the human impact is something that nature is not able to regenerate or absorb. A group of researchers led by Professor Rockstrom worked on this, and there is a paper in nature that was published in 2009 called Safe Operating Space for Humanity. So, what the researchers did was look at a large number of different parameters and see what the natural equilibrium was for these parameters before started industrial activity, and then, based on that, they also identified through some models how much and what the limit was for that criterion. So, with that, they identified a set of nine (9) different criteria that were critical for humanity to operate within a certain safe regime, and in those nine (9) criteria, they identified three (3) where we had already exceeded the limits. Anthropogenic pressures on the Earth's System have reached a scale where abrupt global environmental change can no longer be excluded. We propose a new approach to global sustainability in which we define planetary boundaries within which we expect that humanity can operate safely. And in all the cycles, you can look at the paper for details: there is a proposed boundary, there is a current status, and then there is a pre-industrial value. So, for instance, for climate change, the pre-industrial value is 280 parts per million by volume of CO2, and the proposed 350 parts per million by volume and current status has gone up.

Planetary Boundaries: Exploring the safe operating Space for Humanity

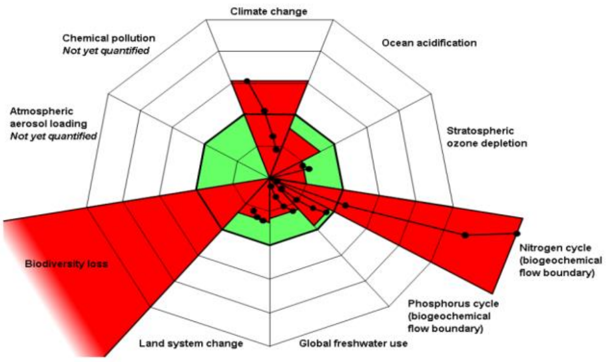


Figure 7. Planetary Boundaries

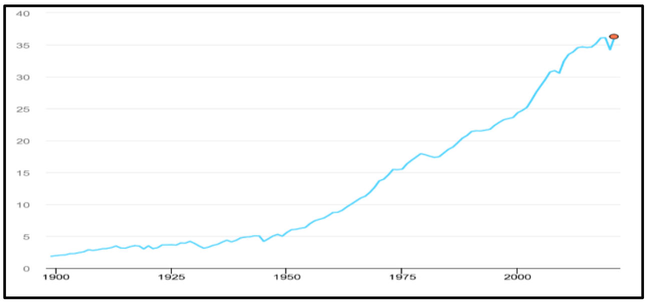


Figure 8. Estimates of CO_2 Emission

Energy-related CO2 emissions grew to 36.3 Gt in year 2021, a record high.

***3.1 The* history** of human development has had a number of eras, and if we look at the history of the world on a large time scale (X Axis in Thousand Years), Refer to figure '9' below. It is known the earth is the only planet where there is life, and this is because it has the atmosphere, which maintains the temperature constant at a particular value. Although Earth has undergone many periods of significant environmental change, the planet's environment has been unusually stable for the past 10,000 years. This period of stability is known to geologists as the Holocene. It is only in the last 3–4 thousand years that humankind has enjoyed a relatively stable environment, and this is the period where actually life evolves and civilizations evolve. This is called the Holocene, and this is the period where human civilization had significant growth, significant development, and significant improvement in humankind. Such stability may be under threat. Since the industrial revolution, a new era has arisen, the Anthropocene, in which human actions have become the main driver of global environmental change. This could see human activities push the earth's system outside the stable environmental state of the Holocene, with consequences that are detrimental or even catastrophic for large parts of the world. During the Holocene, environmental change occurred naturally, and earth's regulatory capacity maintained the conditions that enabled human development. Regular temperatures, freshwater availability, and biogeochemical flows all stayed within a relatively narrow range. Now, largely because of the rapidly growing reliance on fossil fuels and industrialised forms of agriculture, human activity has reached a level that could damage the systems that keep the earth in the desired Holocene state. The result could be irreversible and, in some cases, abrupt environmental change, leading to a state less conducive to human development. Without pressure from humans, the Holocene is expected to continue for at least several thousands of years. This Anthropocene, it has been shown, is not going to be sustainable into the future unless we make some changes in the way we develop and operate our energy system.

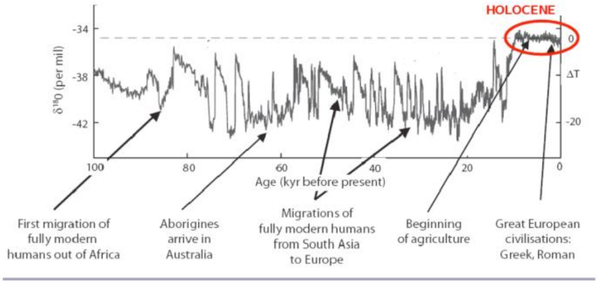


Figure 9. Long Term Global Temperature Record.

Anthropogenic activities are also disrupting biogeochemical cycles. Carbon levels are 36 times higher than preindustrial levels, phosphorous levels 13 times higher, and nitrogen levels 9 times higher. The nitrogen in fertilizers accumulating in nature pollutes water (excessive nitrates in drinking water), reduces air quality, depletes the ozone layer and accelerates global warming and biodiversity loss. The excessive runoff of nitrogen into rivers and oceans increases algae blooms, which are depleting ocean oxygen and killing aquatic flora and fauna. Satellite images suggest that about 1.15 million square kilometers of the ocean surface may be eutrophic zones, with a large part of them being dead zones.

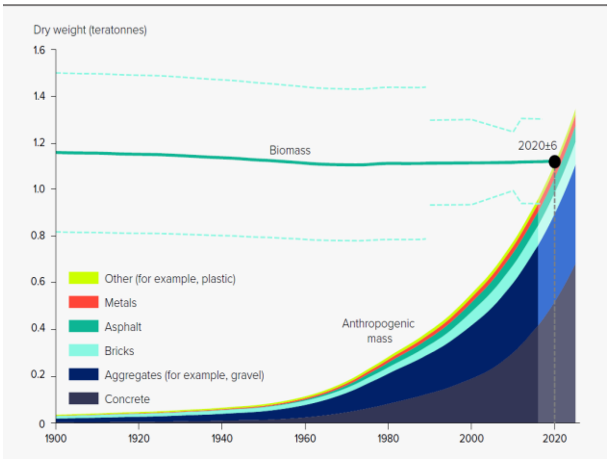


Figure 10. Anthropogenic VS Biomass of World.

3.2 Health: *Energy* systems are currently responsible for a large proportion of the global burden of disease, which is in the order of five million premature deaths annually from air pollution and other energy-related causes and more than 8% of all ill health (lost healthy life years from both morbidity and premature mortality). Air pollution from incomplete combustion of fuels and biomass burning is a major contributor to ill health. As cooking fuel is the greatest source of household indoor air pollution, and a significant source of outdoor pollution. Outdoor air pollution in both urban and rural areas accounted for 2.7 million premature deaths globally in 2005, while about 2.2 million premature deaths are estimated to occur annually from exposure to indoor air pollution in developing countries, mainly among women, the elderly and young children. Other sources of outdoor air pollution include the transportation sector, industry, power plants, and space conditioning. Occupational health impacts, particularly from harvesting/mining and processing biomass and coal, are currently the next most important impact on health from energy systems. Miners are exposed to collapsing mine shafts, fire and explosion risks, toxic gases (carbon monoxide), lung-damaging dusts (coal and silica), and hot work environments, as well as injury and ergonomics hazards. Oil and gas workers face injury risks, particularly during drilling, emergency situations, and work on offshore platforms, as well as exposure to toxic materials at refineries. Unlike biomass and fossil fuels, nuclear power systems are not a significant source of routine health impacts, although they often garner considerable public and policy concern. Average radiation doses to workers in nuclear power industries have generally declined over the past two decades. For nuclear power facilities, as with large hydroelectric facilities, the major health risks lie mostly with high-consequence but low probability accidents. Climate change is beginning to have an important impact on health, causing an estimated 1,50,000 premature deaths in 2000, with more than 90% of these occurring among the poorest populations in the world. Both the direct health burden and the share of climate change impacts due to energy systems are expected to rise under current projections of GHG (Green House Gas) emissions and changing background health conditions in vulnerable populations. Climate change affects the social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter. Between 2030 and 2050, climate change is expected to cause approximately 2, 50, 000 additional deaths per year, from malnutrition, malaria, diarrhea and heat stress.

Latest Carbon dioxide reading January15, 2023 is 420.45 ppm

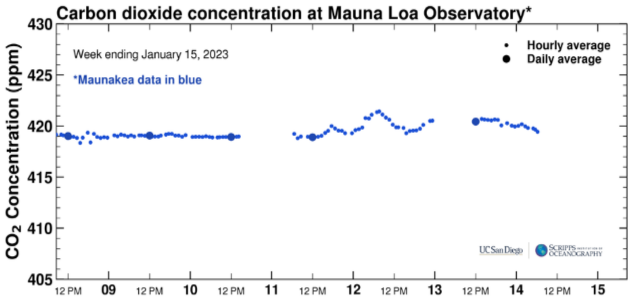


Figure 11. CO_2 Concentration(ppm)

3.3 Economics: Does a country that has a lower energy intensity per unit of GDP imply that it is more efficient? Think about it: let us say India and Singapore, and India's energy use per GDP is higher than the energy use in Singapore; does that mean India is more inefficient in terms of energy used than Singapore? So, the answer to this is that it is not necessary; energy intensity depends on GDP, which is the total value added of the goods and services produced by the economy. So, if you look at the economy, different economies have different kinds of output. So, when, look at an economy that has a large amount of agriculture, an economy that may have a large amount of industry, and an economy that may have a large number of services. Industry, by its very nature, and if you look at heavy industry, is energy intensive, so if you want to produce steel or cement, you will need a minimum amount of energy to do that. If there is a country that is only importing steel and cement and is mainly focusing on the service sector, it will have a lower energy intensity. If we look at energy intensity per GDP, we find that beyond a point where there is no additional amount of energy needed, there is growth and stabilisation.

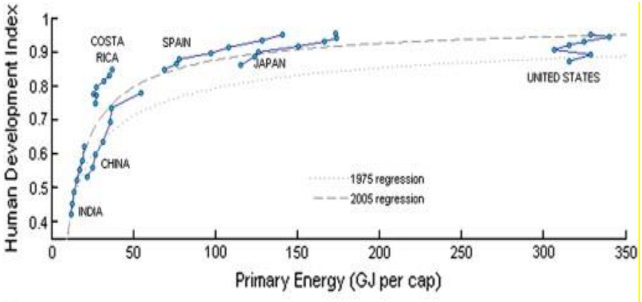


Figure 12. Relationship between Energy Consumption and Human Development Index (HDI)

So, beyond the point, this electricity use does not necessarily result in an improvement in quality of life, and this could be, for instance, if you see the US or some of the developed countries, where you will find that the electricity use has not necessarily contributed to an improvement in quality of life. So, essentially, what happens is that when think in terms of a country like India, where at a particular point and we want to improve the quality of life, we will need to increase the electricity services, the energy services, and so we have a target, and then the per capita energy use will need to increase, and we need to design our energy systems to go for this.

In Paris, the Paris Agreement a couple of years back, essentially where all countries got together, and in the IPCC meetings, there was the problem that it was difficult to get a consensus. There are countries that are emitting much more than their global share, but they are also highly developed, and they do not want to change their trajectory. So even to decide whether we should have an emission norm, which is CO_2 per person, and give a right to emit, which is on a per capita basis, was not agreed upon. The COP-27 (Conference of the Parties) summit, also known as the UNFCC (United Nations Framework Convention on Climate Change Conference), held in Egypt in November 2022, closed with a breakthrough agreement to provide loss and damage funding for vulnerable countries hit hard by floods, droughts, and other climate disasters, reduce GHG by 43% by 2030, limit the warming to 1.5 °C global atmospheric temperature, and mobilise more financial support for developing countries. We expect that we will get some funding from the International Green Climate Fund for this. We also plan to create an additional carbon sink of 2.5 to 3 billion metric tonnes of CO2 equivalent through additional tree cover and forest.

***3.4 Energy* and Quality of Life**: *Energy* needs for development and an improved quality of life. So, when you look at quality of life, we think in terms of the general wellbeing of individuals and society. So, what are the parameters? If you look at your own day-to-day life, what do you think affects your quality of life? You may also want to think about where, if you had a choice, you would like to live. In India, would you like to live in a city or a village? Which city would you like to live in, and why would you like to live in that city? And if not in India or anywhere in the world, if you had the option, what would be your choice?

With variation in the GDP per capita and income per capita of different countries of the world, the Human Development Index is one of the matrices that can be used to compare the quality of life of people in different countries of the world. And there are also other indices called the Happy Planet Index. Gross National happiness has been proposed by countries like Bhutan. If look at the Human Development Index (HDI), there are essentially three different parameters: life expectancy at birth, i.e., a long, healthy life (Health index), GDP per capita, or Gross National income per capita on a purchasing power parity basis (Income index), and the third one is in terms of education or illiteracy (Education Index).

Human Development index (0 - 1), 2021 - Country rankings: The average for 2021 based on 184 countries was 0.723 points. The highest value was in Switzerland: 0.962 points and the lowest value was in South Africa: 0.385 points. India ranks 127 in the list with HDI 0.633. Gross National Income was about 6590 dollars (PPP rate) per year per person. The indicator is available from 1980 to 2021.

Table 1. Human Development by Country, around the World.[6]

Countries	Human development, 2021	Global rank	Available data
Switzerland	0.962	1	1980 - 2021
Norway	0.961	2	1980 - 2021
Iceland	0.959	3	1980 - 2021
Hong Kong	0.952	4	1980 - 2021
Australia	0.951	5	1980 - 2021
Denmark	0.948	6	1980 - 2021
Sweden	0.947	7	1980 - 2021
Ireland	0.945	8	1980 - 2021
Germany	0.942	9	1980 - 2021
Netherlands	0.941	10	1980 - 2021
Finland	0.94	11	1980 - 2021
Singapore	0.939	12	1990 - 2021
Belgium	0.937	13	1980 - 2021
New Zealand	0.937	14	1980 - 2021
Canada	0.936	15	1980 - 2021
Liechtenstein	0.935	16	2000 - 2021
Luxembourg	0.93	17	1980 - 2021
UA Emirates	0.929	18	1980 - 2021
Japan	0.925	19	1980 - 2021
South Korea	0.925	20	1980 - 2021

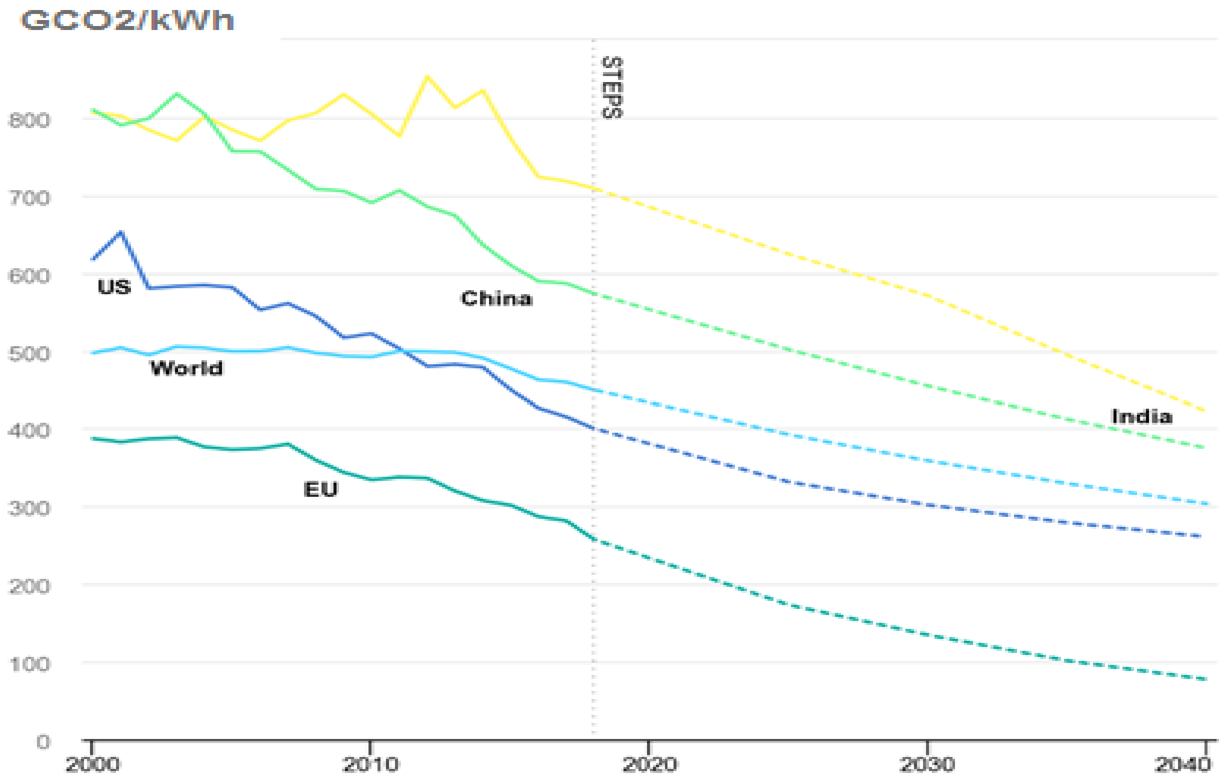


Figure13. Emission of CO_2 per Unit of electricity production

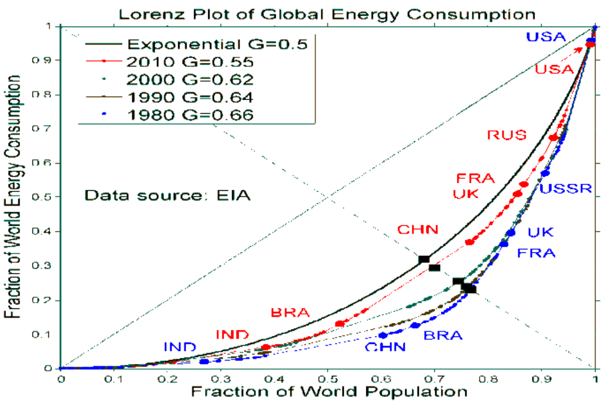
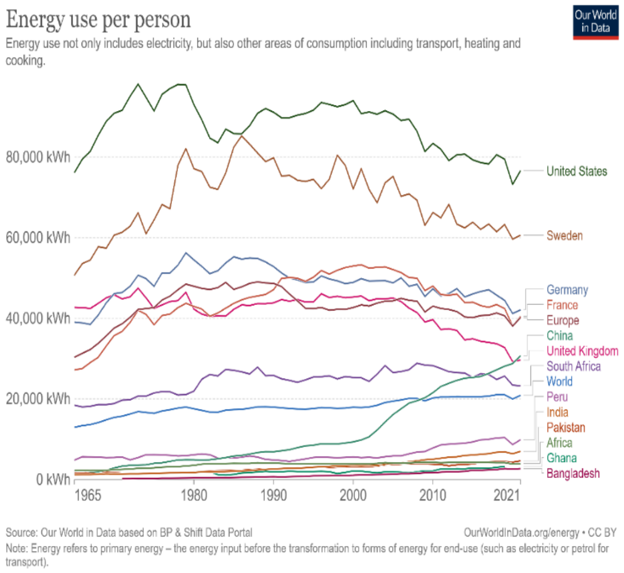


Figure 14. Energy and Equity [3]

***3.5 Energy* and Equity:** If look at the world, this was done in the global energy assessment, and you can see that there is a fairly significant inequality in the final energy and the electricity use. For instance, if you look at the richest 10%, they consume 40% of the world's electricity and final energy, while if you look at the poorest 50%, you will find that the poorest 50% consume 10% of the total cumulative energy. The global average for energy consumption per person is 20,902 kWh per year. India consumes in order of much less magnitude than the world's average, i.e., 6,992 kWh, with the highest consumption by the United States, i.e., 76,634 kWh. The important factor is to add more renewable energy generation to the energy mix to reduce the carbon intensity of electricity, which is now at 441 grams of CO_2 emitted per kilowatt-hour of electricity generated in the world. Some of the countries that have already imposed carbon taxes as of 2020 are Canada, Norway, Japan, Colombia, France, the UK, Denmark, Argentina, Iceland, etc.



Source: Our World in Data based on BP & Shift Data Portal OurWorldInData.org/energy • CC BY
Note: Energy refers to primary energy – the energy input before the transformation to forms of energy for end-use (such as electricity or petrol for transport).

Figure 15. Energy use per person a comparative study [4]

3.6 Energy Security: Looking at various dimensions of energy; i.e., energy and the environment, energy and development, energy and quality of life, and energy and equality. The last dimension that needs to discuss is Energy Security. It is the uninterrupted provision of vital energy services. And this is, of course, a priority for every country. There are three different dimensions: the first is robustness, the second is sovereignty, and the last is resilience. It should have sufficient resources, reliability of infrastructure, stable and affordable prices, protection from potential threats from external sources, and the ability to withstand diverse disruptions. You must have read in the newspapers, many different issues related to energy security. If you look at Japan, the country as a whole has a very low self-sufficiency ratio in energy. A low self-sufficiency ratio means that a country has a strong dependence on energy imports. The country does not have fossil fuel reserves on its land, so 90% of the dependence for the primary energy supply input is from coal, oil, or natural gas from different countries. About 86% of the crude oil is imported from the Middle East. Hence, Japan introduced new laws, such as the feed-in tariff system, so that renewable energy has grown at a significant annual rate since 2010. For example, let us look at Australia. The country has an abundant amount of primary energy in its earth capital. It is the sixth-biggest country in the world, with a population of 2.6 crore. Out of this, 30% of the population are youngsters, who contribute more to their GDP. If we talk about energy, 40% of it comes from coal and 29% from natural gases, but the amount of renewable energy is very low. Sector-wise, transportation sectors and industrial sectors consume more energy. Hence, Carbon intensity is higher in Australia. The energy intensity of Australia is higher than that of India. Regarding significant policies, Australia has the target of reducing 26 to 28% of CO2 emissions by 2030. And Australia has targets like the large-scale renewable energy target and the small-scale renewable energy scheme. The large-scale renewable energy target says that those who are using more energy for their industry operations should use a particular amount of energy from renewable sources. Finally, Australia has lots of CO2 emissions, and per capita CO_2 emissions are very high. They have a lot of uranium energy as well as sunlight, so they can make use of uranium and sunlight. They can start with renewable energy sources like solar and uranium. So, the CO_2 emissions will be reduced, as will the diversification of fuel, which is very important for Australia as its energy security can be improved because of that. The energy bottlenecks should be taken care of by Australia to take a further step towards renewable energy sources. Mexico falls under the middle-income category of the World Bank, with a per capita GDP of about 9 US dollars. The HDI rank is 85 (1980–2021) with a HDI of 0.758. Concerned about the climate change issue, they have increased the share of natural gas in the total energy mix as NG is less polluting than coal and oil. The energy intensity of the economy has been decreasing significantly; this is primarily because of the shift in the economy from a manufacturing base to more services and exports. Mexico has been very aggressive in terms of dealing with climate issues. They have targeted that a minimum of 35% of electricity would come from clean energy sources by 2024 and cut emissions by 50% by 2050.

3.7 *UTILITY* AND SOCIAL CHOICE:

We want to look at, when you have a society of a number of individuals, how the society does makes choices and specifically we are interested in choices which relate to environment and development. We want to ask the following questions in environmental policy.

What is the right balance between environmental protection and use?

How much of environmental protection should we have?

And this question is not an easy question to answer. It is a social and political question.

Example: A city in Chile, Santiago. Santiago is one of the busiest cities in Chile and Latin America, and it has a severe air pollution problem. A lot of this problem is based on diesel private vehicles as well as diesel buses. And there are many different possibilities; the buses are used by the poor, and they have relatively low prices. In Chile, like many other developing countries, there is a significant amount of inequality. So, there is a small proportion of the population that is rich, and the rich population is more concerned about the air pollution than the poor, but the health impact happens to everyone who stays in the city. And so, the question is, how much investment should the city make in terms of pollution control? Can it modernise its bus fleet? If it modernises its bus fleet, the cost of public transport and fares may increase, making it less affordable for many of the poor to travel by bus. And so, this is one of the choices that are there. It is a very clear choice in terms of air quality, environmental damage, the kind of value, the value proposition, and the price.

The second example that Kolstad (Charles Kolstad on Environmental Economics) gives is the largest electricity dam project in the world. It is a Three Gorges Dam in China, which is on a large scale, at the Giga watt scale. The reservoir is 500 kilometers in length. It had a lot of opposition initially, but the Chinese government went ahead and built it. About 1.4 million people were displaced when construction began, and 13 cities, 140 towns and 1,350 villages were submerged when the reservoir reached its full capacity of 40 billion cubic meters. The benefits of this will go to the generation of electricity as well as the development of the country. In terms of losses, it means that the local population gets resettled, and then there are several other issues because of this large dam of water. And these kinds of issues globally are affecting almost all large hydro projects, and in many countries, this has resulted in severe delays and sometimes even the cancellation of some of these projects.

Let us look at a few examples from India, such as the Narmada Valley project. You will find that this is one of the largest hydroelectric projects, both for electricity and irrigation, in the country. It involved a whole set of different states. There are states downstream and upstream, and the benefits accrue to a set of farmers and a set of regions, while the losses occur to people who are in the project affected zone. There was a very strong movement called the Narmada Bachao Andolan, and there were several court cases. The heights of the dam were reduced, and overall, the project was delayed significantly by several years, which resulted in cost overruns.

But when you look at projects like this, this is where there is this choice of development and environment. How do you assess and decide to make a social choice, and what are the kinds of ways in which you can do that?

So, one of the largest companies in the world, Vedanta, wanted to mine Bauxite for Aluminium refining at Niyamgiri hills in Orissa, and the Niyamgiri hills were one of the few habitats where there are tribals, and the trees in those hills have a religious value to them. The protection of the hills and the habitat was opposed by several NGOs and locals, and there was a standoff between the project proponents and the project opposer. And this is where the courts got involved, and finally, this was the one example in which it was decided by the ministry and the courts that the residents, the villages that were affected in these hills, would have an election. And the project was to be decided; there would be voting on whether the project would be a yes or a no. And it would be done at each Gram Panchayat level. There were observers coming in; this is widely reported, and there are videos and newspaper reports about it. This was the first time this was done for an environmental project, and interestingly, each and every village rejected this proposal, with the result that this bauxite mining proposal was cancelled.

Iron ore mining in Goa has become a sort of political issue. The mines were closed and then so because of environmental damage and land use and so, again this is again another open kind of issue, the advantage any mine or any industry that you talk off will create jobs, will create development, but on the flip side is that it will have an impact on the land use, it will have an impact on the environment and we have to make tradeoffs between this.

In Mumbai there is a large coastal road project going all the way to South Mumbai and again this is a heavy investment and this had several opponents and I believe that with the change in government, this may again be reviewed. The most cities in India now are going in for expansion of public transport with metros and metros of course are that way environment friendly because they are reducing the local emission, they are reducing the congestion as well as the CO_2 emissions. For the metros, you will have to have locations where the metros will be parked and that means there is sheds which will take a reasonable amount of land area, in a city like Mumbai. You do not have large tracks of land which are still available. The metro shared is planned in Aarey and Aarey colony is one of the few green patches in the city. And so there has been opposition to the metro shed in Aarey, there were protests and there was a Supreme Court case. Some trees were chopped down and this was an issue in the elections, and subsequently, this is again going to be reviewed with the change of government. So, as you see, these are some of the examples which illustrate to you that there are many different aspects when we look at many of these projects.

3.8 Tradeoff between development and environment*: There* is always a tradeoff that think in terms of development and the environment. Hence need to understand what are the perspectives or the individual beliefs based on which we are going to do the analysis. So, you can read up about most of these projects. If you just Google them you will get details. So, let us have a look at the kind of different philosophical perspectives. So, that is to look at essentially three perspectives.

1. **Biocentrism**
2. **Sustainable**
3. **Anthropocentric**

Biocentrism: It basically focuses on the fact that every living organism has intrinsic value. So, in biocentrism, the biologic world is the center of the value system; all living beings have intrinsic value, regardless of their instrumental value. So, only those things that can serve some useful objective will be said to have an instrumental value, and in the case of biocentrism, all living organisms have an intrinsic value, irrespective of whether or not they have any use, irrespective of whether or not they have any instrumental value. So, something can be totally useless and always have intrinsic value. Example: The smallpox virus, in a biocentric world, has a value, and you would not want to destroy it. However, we consider that the smallpox virus is useless and actually has a negative value and damages, but we in the biocentric world think that all life is important, and want to perceive and preserve life. So, in a similar fashion, if you have a biocentric view of the world, even if you have someone who is a known murderer, you would not prescribe a death sentence because you feel that life itself has value. And even though that person has a negative value in society, you would still continue to keep him in prison, but you would not destroy him because life itself has an intrinsic value. If you have a biocentric view of the world, you would try to preserve not only individuals, but also all types of organisms. And so that is one kind of perspective—a philosophical perspective—that we have.

The second perspective is sustainability: Want to preserve the health of the ecosystem. The sustainability perspective initially proposed by Leopold, way back in 1949, talks of the land ethic and the health of the ecosystem as being of paramount importance. So, you want to make sure that the land remains fertile and that the land remains beautiful, and we would like to keep it in that fashion. So, in the case of sustainability, we are looking at an environmental policy as right only if it preserves the integrity of an ecosystem and wrong if it does not. So, the question is, is this consistent with natural resource use by humans? It could be, so it depends on it, provided the use does not degrade the environment. For instance, fishing is acceptable, but overfishing is not, because if you overfish, the entire population of fish in the rivers would vanish, and that is not sustainable. The logging is acceptable, as is the cutting of trees, provided the long-term health of the forest is not affected or jeopardized. And so, this is consistent; however, if you look at fishing, it will not be consistent with the biocentric view of the world because living fish have their own value, and you will not be allowed to damage that. Sustainability term is commonly used but often not precisely defined. A few decades ago, the Brundtland Commission defined sustainability as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. And this is, of course, mostly a human centric definition, but when we are talking of the land ethic and sustainability, we are also looking at the sustainability of the overall ecosystem. Robert Solow has defined sustainability as making sure that the next generation is as well off as the present generation and ensuring that this continues for all time. What are the two aspects of sustainability that are important? The first is the degree to which natural capital can be viably replaced by human capital. So, we always started with having things available in nature. We have a number of different processes and natural cycles; the history of human development has been one where we have made our own ways of doing things and mimicking nature. So, we replace natural capital by human capital, by technology, by materials, and by devices. And so, this is to what percent, you know, to what extent can we do this, and we do this essentially to make our lives more comfortable. The second part of sustainability is that, the present generation, have an obligation to future generations, and so we also look at sustainability in terms of how we fulfil that obligation so that future generations can enjoy at least the same quality of life that we enjoy. So, man-made capital, when we talk of machines, is building. So, for instance, earlier day lighting and ventilation were being used, but now we create lights, artificial lights, condition the air in the buildings, and then imitate nature, and we are able to do that so that we can control and increase our comfort. So, manmade capital and, most importantly, knowledge and information are now being looked at as substitutes for natural capital, particularly natural resources. There are limits to this, of course, and there are physical requirements that are not necessarily going to be substitutable. So, the question is, are sustainability and biocentrism consistent? In many cases, they are not. For instance, hunting can be acceptable from a sustainability viewpoint; it may be desirable to reduce overpopulation; and there may be a limiting condition in which different ecosystems and different species can coexist in a certain area. So, it may be natural from an ecosystem and sustainability viewpoint to have hunting, but it is not acceptable for biocentric. So, understand two distinct perspectives: the first one was biocentrism, and the second one was sustainability.

Let us look at the third perspective, which is anthropocentrism. So, anthropocentrism is basically a human-centric viewpoint, and the thinking is that only human beings' matter and the environment is only there for one purpose: to provide material gratification for humans. This is also an extreme kind of thing. But if you see the way in which human civilization has been progressing, we behave as if everything is there for us and we can exploit it as long as it serves our purpose. So, anthropocentrism only provides an instrumental value to the environment, which means the environment is important only so far as it is useful to us. But if we are polluting the ecosystem and it does not affect humans but is affecting the rest of these civilizations, then we are not concerned about it. So, this is an extremely selfish and human centric viewpoint, which often fairly reflects the way in which development is occurring today.

The other slight variant of this is utilitarianism, where we talk about the wellbeing that people attain from the environment, which could be materialistic, spiritual, instrumental, or intrinsic. So, for instance, if we talk about the Californian Gnatcatcher, as an example in Kolstad's book, it is something that does not have an environmental, useful value. And we are not very clear about its contribution to the ecosystem in terms of its impact on humans. But it may have a utilitarian value because several people may be happy that we have this species and that it has not become extinct. People may come and visit and see the California Gnatcatcher even if they are not in that locality. The very feeling that we have, the perception that it has been saved and there is a forest, may give you a positive feeling, and you may get a utility from that, and that is from a utilitarian perspective.

3.9 UNCERTAIN TIMES, UNCERTAIN LIVES: SHAPING OUR FUTURE IN A TRANSFORMING WORLD

Life has always been uncertain. The world has faced wars, pandemics and massive natural hazards before. Today's uncertainty is not necessarily any greater than in the past. If anything, given record achievements in average standards of living and incomes, with astonishing technological progress, we could be expected to be more ready than ever to meet uncertain times. Yet, we display high, and often rising, concern about the future. So, what is going on? Why are people so worried, and what worries them? If today's world is not more uncertain than the past's, are today's uncertain times different? If so, how? And how do they relate to human development?

Wars and pandemics threaten human development. The Anthropocene is driving new hazards to humans and deepening inequalities among people. Coping with these dynamics and reducing planetary pressures bring to the face new kinds of challenges and uncertainties. Astonishing technological innovation offers promise but also presents unprecedented circumstances. Seen in isolation, today's many challenges are not new but, in their interaction, present a new "uncertainty complex," unsettling people's lives. Indeed, anxieties are high: 6 of 7 people globally report feeling insecure about many aspects of their lives. Political polarization complicates matters further. It has been on the rise, and uncertainty makes it worse and is worsened by it. Large numbers of people feel frustrated by and alienated from their political systems. In a reversal from just 10 years ago, democratic backsliding is now the prevailing trend across countries. This despite high support globally for democracy. Armed conflicts are also up, including outside so-called fragile contexts. For the first time ever, more than 100 million people are forcibly displaced, most of them within their own countries. There is both promise and peril in uncertainty; tipping the scale towards promise is up to us. Advancing human development is not only the aspiration but also the means to navigate uncertain times and effect the behavioural changes and institutional reforms that would allow us to shape a more hopeful future.

4. Results

Energy has become a very fundamental aspect of our existence. Our behavior is linked to energy use. We examine that GDP and energy consumption seem to be closely linked. The GDP of the various nations is often very closely related to energy consumption. We must adopt non-conventional and renewable energy, develop technology to harness efficiently and distribute effectively to get rid of this dangerous situation. We have abundant source of renewable energy available i.e., Solar energy, wind energy, tidal, geothermal, biomass, fuel cell, etc. Thing is to do intensive research for development of technologies which are in a position to address this level of usage to harness renewable energy so as to meet the energy demand of the world so that we can actually make an impact on environment. For example, human kind use energy 500 EJ/year and Earth receives energy from the Sun is estimated to 5.5 million Exajoules per year. That means the entire energy use in a year, we can get from Sun within one hour. The Temperature of 90% of sea water below thermocline is around 3^0C. By efficient adoption of OTEC technology, plant can be set up in almost all coastal zone to run central air-conditioning system to replace the present air conditioning system which consume electricity as well as refrigerant gas consists of Chlorofluorocarbon (CFCs) which causes ozone layer depletion. In non-conventional source of energy, the **MHD** technique can be implemented in Power Generation unit to harness more power with same fuel input resulting improvement of plant efficiency.

5. Discussion

The primary purpose is to talk about the scale of energy use by human in the world, estimate the impact of an atmosphere. Energy use has the major contribution of global warming & climatic change. It threatens the existence of human life on earth. The changing composition of environment is quite significant in past 100 years of time. Humanity depends on fossil fuels for 87% of our energy need. We should take a pause at this moment and see what where is it that we are right now, what is our situation? This is important to find out cleaner sources of energy to save ourselves.

6. Conclusions

It understands the nature is powerful and kind too. In Indian context, our culture i.e., made us practices the "Art of Living" with deep respect to nature. It is very fundamental for sustainable development. We are not the masters. We are only the guest. We should perform our role without damaging the earth. Otherwise, nature will take its own course of action for its existence and extinct or eliminate those are not favorable to her. We should opt for the process of destruction or the process of development. Choice is ours.

Abbreviations

COP: Conference of Parties
GDP: Gross Domestic Product
IPCC: Intergovernmental Panel on Climatic Change
OTEC: Ocen Thermal Energy Conversion
UNFCC: United Nations Framework Convention on Climate change
HDI: Human Development Index
EJ: Exa Joules = 10^{18} Joules
CO_2: Carbon Dioxide
NHD: Magneto Hydrodynamic

Supplementary Material

1. ***The Corporation*** is a 2003 Canadian documentary film : The Pathological Pursuit of Profit and Power written by University of British Columbia law professor Joel Bakan and filmmaker Harold Crooks, and directed by Mark Achbar and Jennifer Abbott. The Corporation is a thought-provoking documentary that presents a controversial and well-informed discussion of the positive and negative influence of corporations in today's society. The documentary examines the modern corporation. The corporation an institution that creates great wealth but causes enormous and often hidden harm to society and the environment.
2. An American documentary film **"An Inconvenient**

Truth" does throw up serious questions about our individual responsibility towards meeting the challenge of climate change. Its main message is that global warming presents a "moral imperative" to each and every person.

3. The Economic Times | Opinion: 11 April, 2023, 7.44 PM IST: Pock Me: India should not replace its dependence on imported oil with reliance on imported solar cells. Synopsis: Keeping energy affordable and financing the growth of the energy sector are two critical challenges. India must be concerned with long term energy security. Prof. Rangan Banerjee is the writer, Head, Department of Energy Science and Engineering, IIT Bombay.
4. See documentary film *see Deepwater Horizon explosion*. The ***Deepwater Horizon* oil spill** (also referred to as the "**BP oil spill**") was an environmental disaster which began on 20 April 2010, off the coast of the United States in the Gulf of Mexico.

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Author Contributions

Anil Pattnaik is the sole author. The author read and approved the final manuscript.

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Data Availability Statement

The data that support the findings of this study can be found at:

1. https:// www.globalenergyassessment.org
2. https://www.iea.org/
3. Source: IEA, World Energy Balances, Aug. 2022.
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7. https://www.science.org/doi/10.1126/science.aam6284
8. https://economictimes.indiatimes.com/opinion/poke-me/poke-me-india-shouldnt-replace-its-dependence-on-imported-oil-with-reliance-on-imported-solar-cells/printarticle/56798456.cms
9. https://www.whitehouse.gov/america-first-energy

Conflicts of Interest

I declare no conflicts of interest.

Appendix

Recommended reading:

1. Energy after Rio: prospects and challenges: executive summary / Amulya K.N. Reddy, Robert H. Williams, Thomas B. Johansson
2. Riding the Energy Transition: Oil Beyond 2040.
   Author/Editor: Reda Cherif ; Fuad Hasanov ; Aditya Pande
3. NITI Aayog, Draft Energy Policy, Govt. of India

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[1] Book by Tester J. W. et al Sustainable Energy

[2] *IEA, World Energy Balances, Aug. 2022.*

[3] MDPI journal

[4] OurWorldinData.org/energy

[5] World Energy Outlook 2023

[6] United Nations Development Programme - Human Development report 2021/2022

[7] Article *in* Nature · January 2013 by Johan Rockström, Stockholm University

[8] The Quadruple Squeeze: Defining the Safe Operating Space for Freshwater use to Achieve a Triply Green Revolution in the Anthropocene by John Rockström

Biography

Anil Pattnaik is an energy professional working as DGM (Captive Power Plant and Energy Manager) at Paradeep Phosphates Limited. The company manufactures Phosphatic fertilizer located at Paradeep, Odisha, India. He is reach in experience of over more than 29 years in the corporate sector mostly in power plant project management, engineering, commissioning, operation, and maintenance of different types and sizes of thermal-based power plants. High productive orientation with skillful thoughts and a cost control orientation. Focused on energy conservation and environmental sustainability. Well organized, attentive to detail, and vigilant in achieving safety and environmental impact reduction objectives. He graduated in mechanical engineering from Utkal University and completed his master's degree (MBA) with specialization in HR and Marketing from BPUT, Odisha, India. He is a life member of **IAEMP** (Indian Association of Energy Management Professionals).

Research Field

Anil Pattnaik: Interested in the field of non-conventional and renewable source of Energy.